US009104173B2

(12) **United States Patent**
Murayama

(10) **Patent No.: US 9,104,173 B2**
(45) **Date of Patent: Aug. 11, 2015**

(54) **IMAGE FORMING APPARATUS**

(71) Applicant: **Brother Kogyo Kabushiki Kaisha**, Nagoya-shi, Aichi-ken (JP)

(72) Inventor: **Kentaro Murayama**, Kasugai (JP)

(73) Assignee: **Brother Kogyo Kabushiki Kaisha**, Nagoya-shi, Aichi-ken (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1 day.

(21) Appl. No.: **14/040,793**

(22) Filed: **Sep. 30, 2013**

(65) **Prior Publication Data**

US 2014/0147153 A1 May 29, 2014

(30) **Foreign Application Priority Data**

Nov. 28, 2012 (JP) 2012-259988

(51) **Int. Cl.**
G03G 15/00 (2006.01)
G03G 21/16 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/1661*** (2013.01); ***G03G 15/5054*** (2013.01)

(58) **Field of Classification Search**
USPC 399/74; 362/249.01, 362, 382; 361/600; 248/220.22; 250/239
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0251435 A1* 12/2004 Sawayama et al. 250/559.16
2014/0084145 A1* 3/2014 Guan et al. 250/216

FOREIGN PATENT DOCUMENTS

JP 2005-037585 A 2/2005

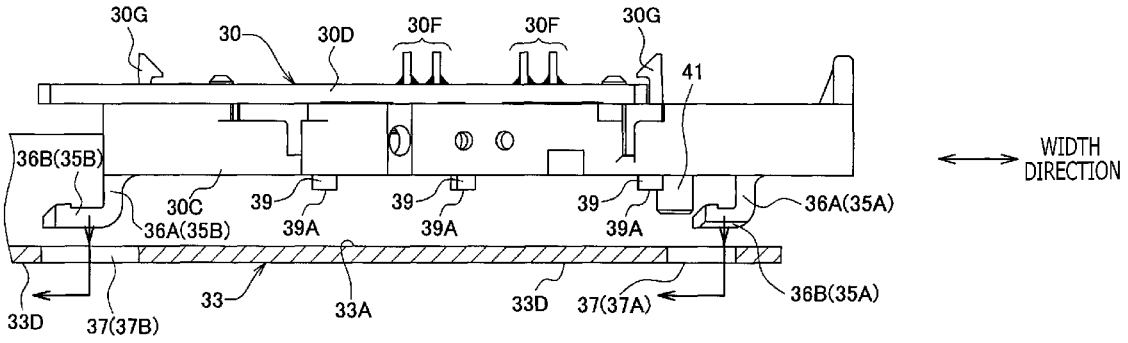
* cited by examiner

Primary Examiner — David Gray
Assistant Examiner — Michael Harrison
(74) *Attorney, Agent, or Firm* — Banner & Witcoff, Ltd.

(57) **ABSTRACT**

An image forming apparatus, comprising: an image formation unit configured to form an image on a sheet; a sensor unit having a light-emitting device and a light-receiving device; a frame to which the sensor unit is attached; at least one projection provided on one of the sensor unit and the frame, the at least one projection being formed to have a contacting part which projects to contact an other of the sensor unit and the frame; and at least one engagement part provided on one of the sensor unit and the frame, the at least one engagement part being formed to engage with at least one catching part provided on an other of the sensor unit and the frame and to press the at least one projection in a direction of increasing a contact surface pressure of the contacting part by causing elastic deformation.

8 Claims, 7 Drawing Sheets



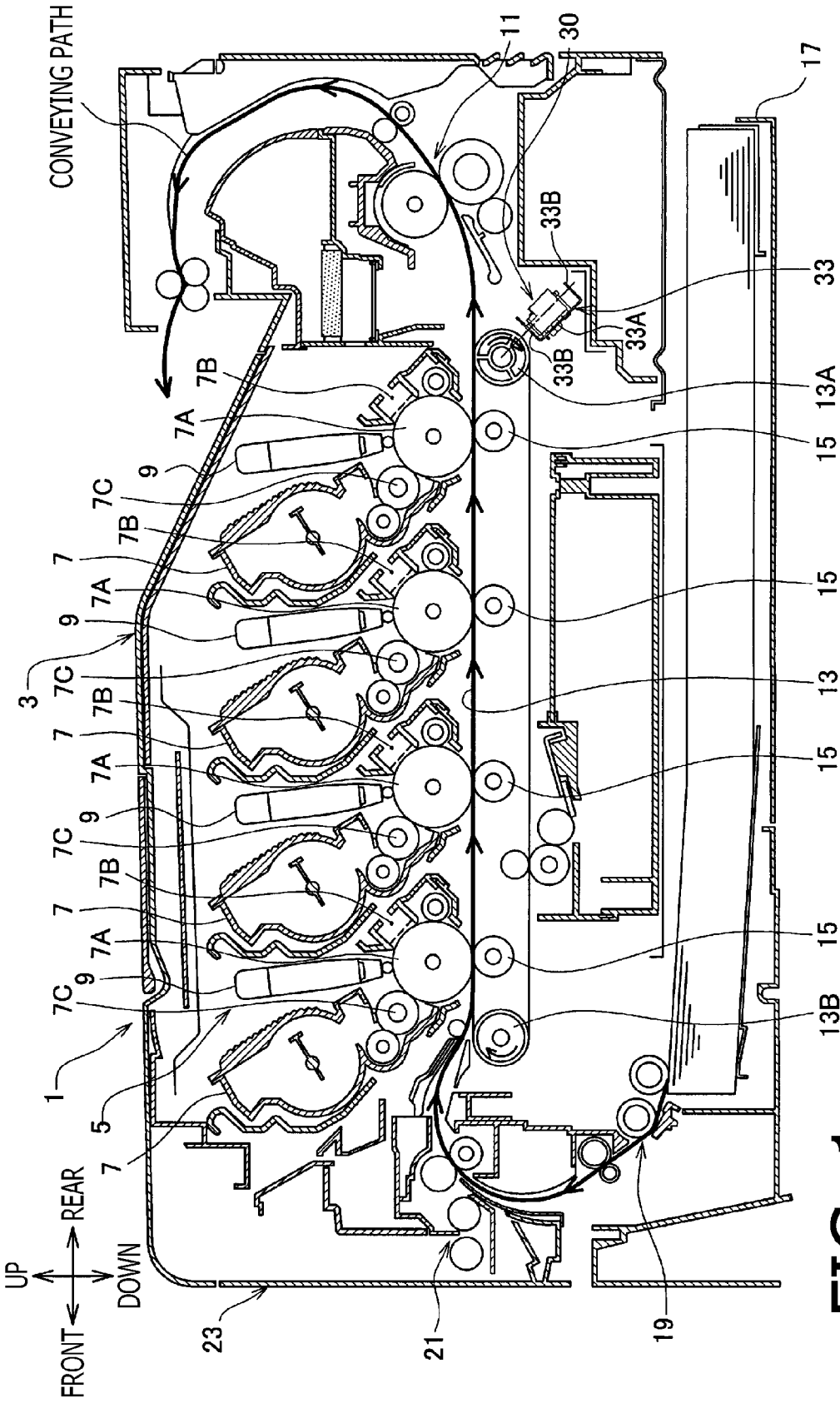

CONVEYING PATH
11
30
17
33B
33
33A
33B
13A
7B
7A
9
7C
7B
7
7A
9
3
7C
7B
7
7A
9
7C
7B
7
7A
9
7C
1
5
7
15
15
13
15
15
13B
UP
REAR
DOWN
FRONT
23
21
19

FIG. 1

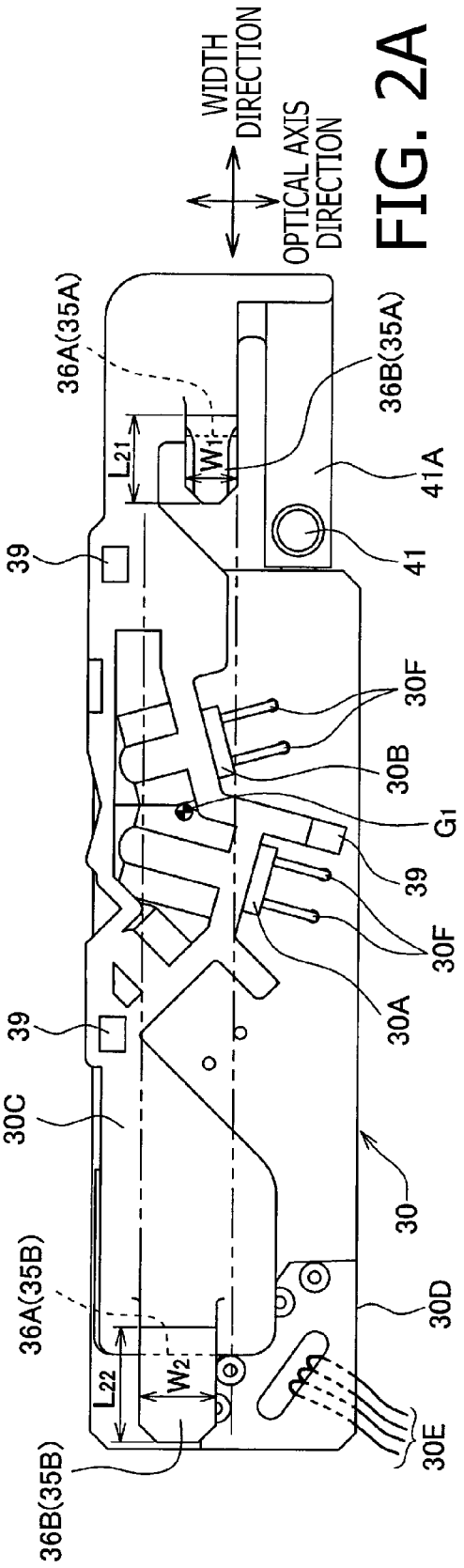

WIDTH DIRECTION
OPTICAL AXIS DIRECTION
36A(35A)
36B(35A)
L21
W1
41A
41
39
30F
30B
G1
39
30F
30A
39
30C
30
36A(35B)
30D
L22
W2
30E
36B(35B)

FIG. 2A

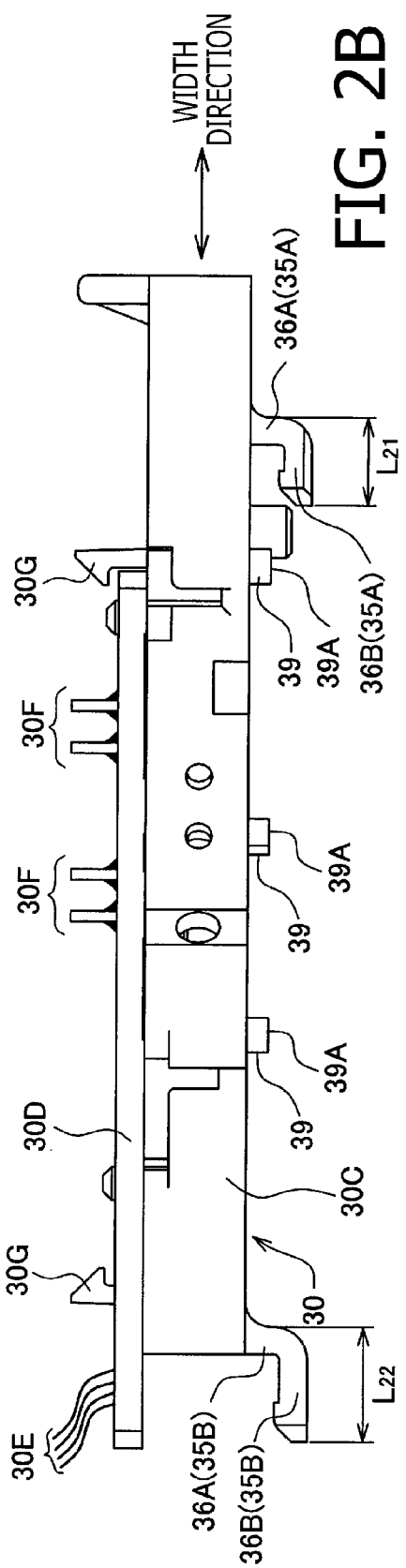

WIDTH DIRECTION
36A(35A)
L21
30G
39
39A
36B(35A)
30F
30F
39
39A
39
39A
30D
39
30C
30G
30
30E
L22
36A(35B)
36B(35B)

FIG. 2B

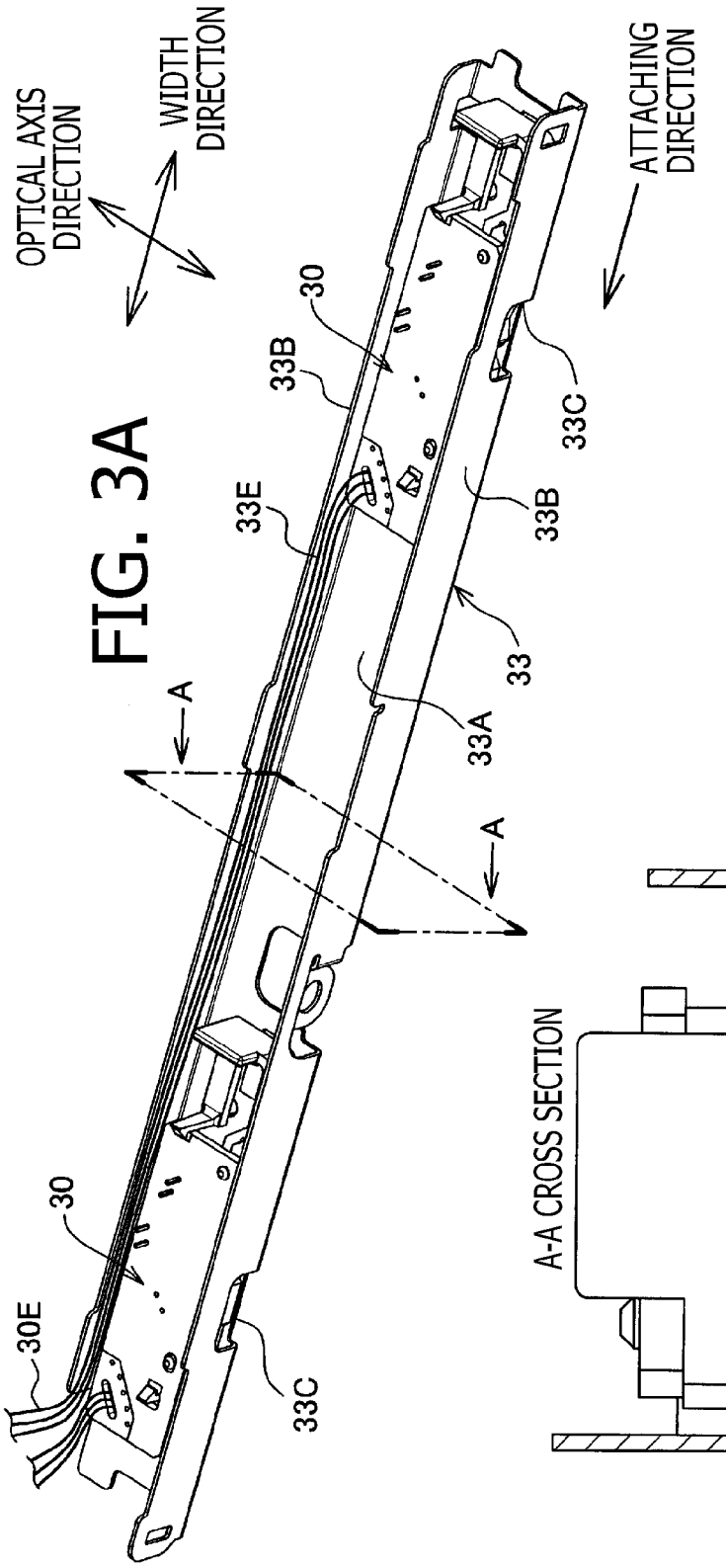

OPTICAL AXIS DIRECTION
WIDTH DIRECTION
ATTACHING DIRECTION
30
33B
33C
33E
33B
33
33A
A
A
30
30E
33C

FIG. 3A

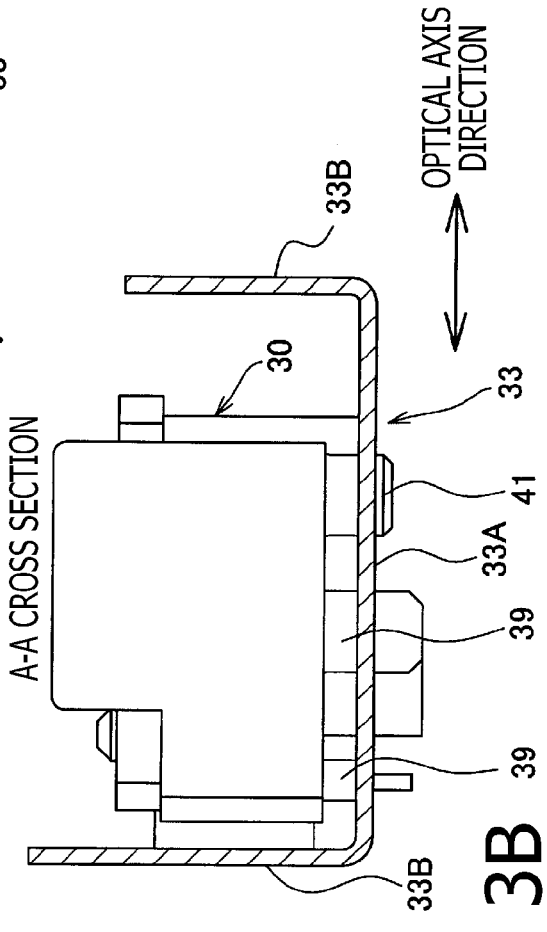

OPTICAL AXIS DIRECTION
33B
A-A CROSS SECTION
30
33
41
33A
39
39
33B

FIG. 3B

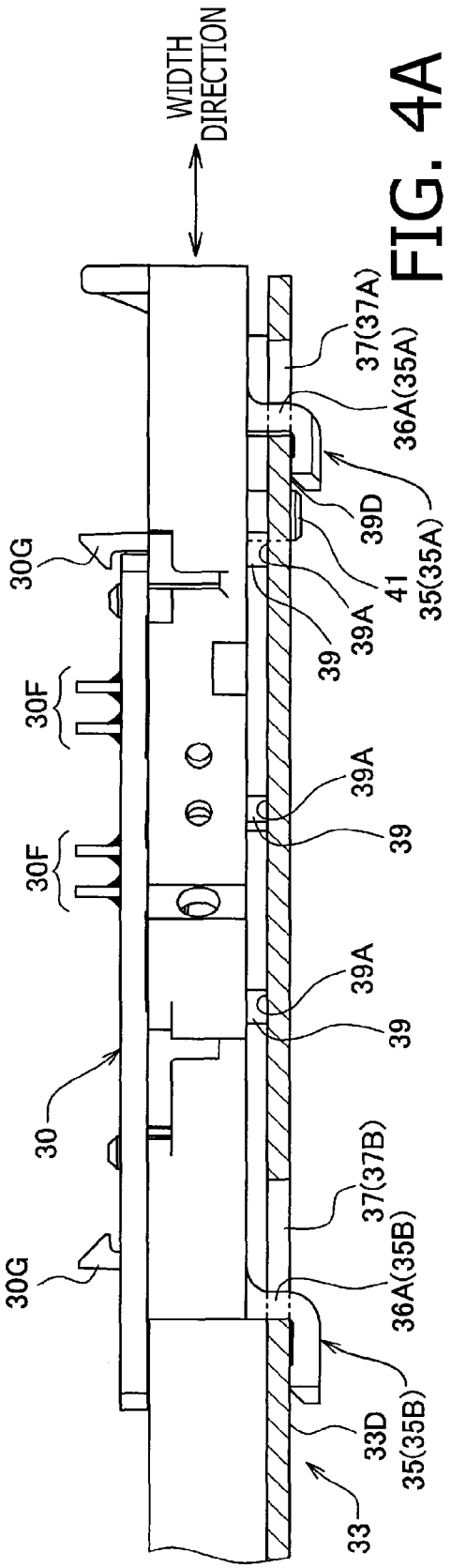

WIDTH DIRECTION
30G
30F
30F
30
30G
37(37A)
36A(35A)
39D
41
35(35A)
39
39A
39
39A
39
39A
39
37(37B)
36A(35B)
33D
35(35B)
33

FIG. 4A

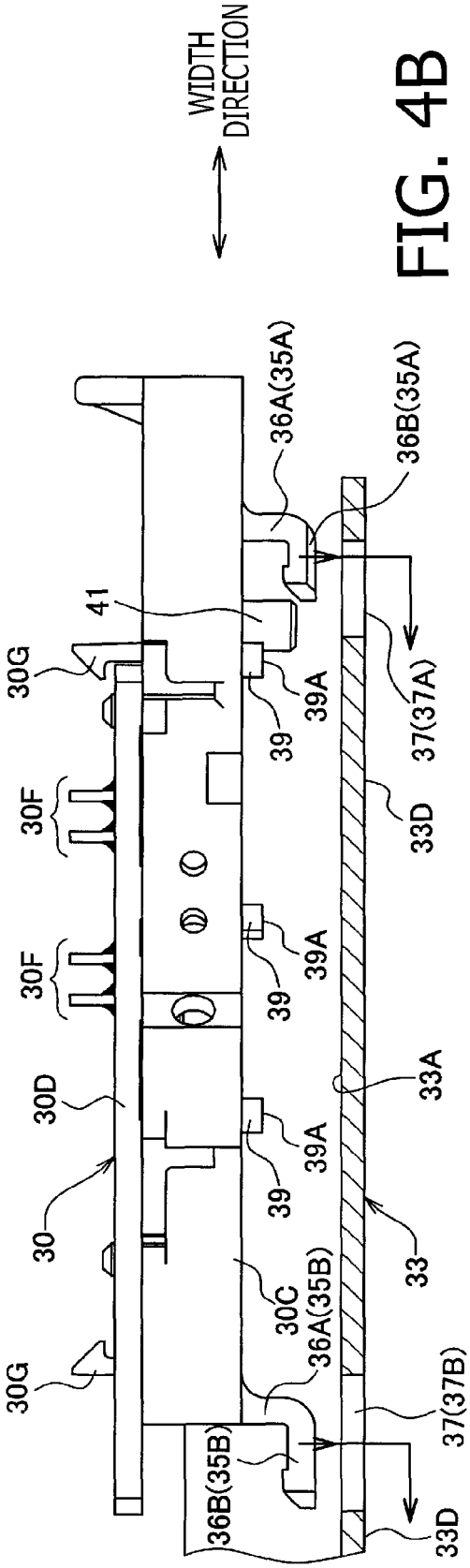

WIDTH DIRECTION
36A(35A)
36B(35A)
41
30G
39
39A
37(37A)
30F
33D
30F
39
39A
30D
33A
30
39
39A
30C
36A(35B)
33
30G
36B(35B)
37(37B)
33D

FIG. 4B

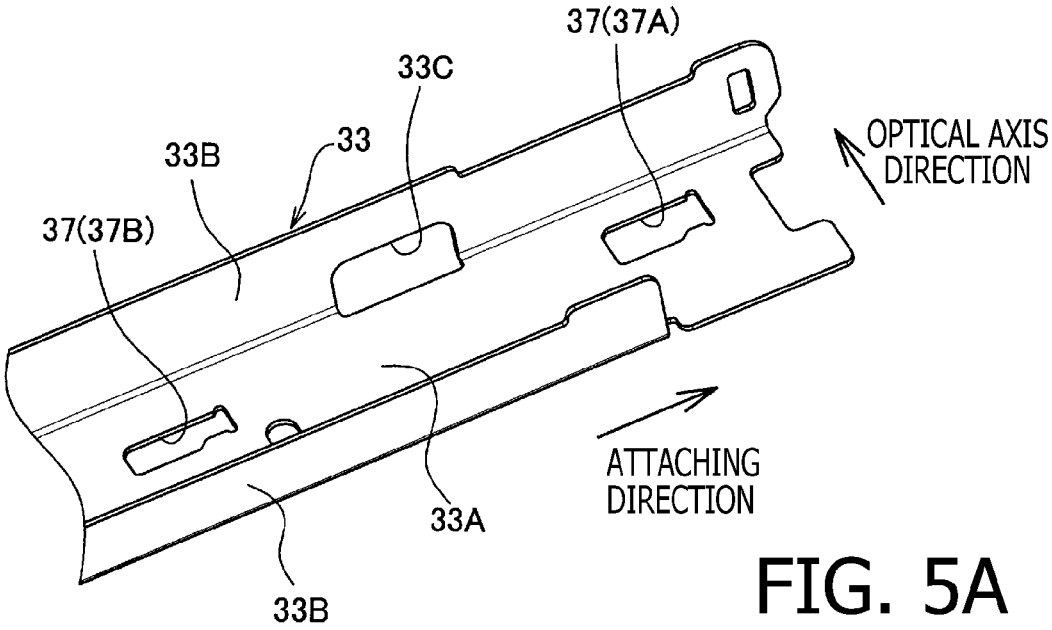


FIG. 5A

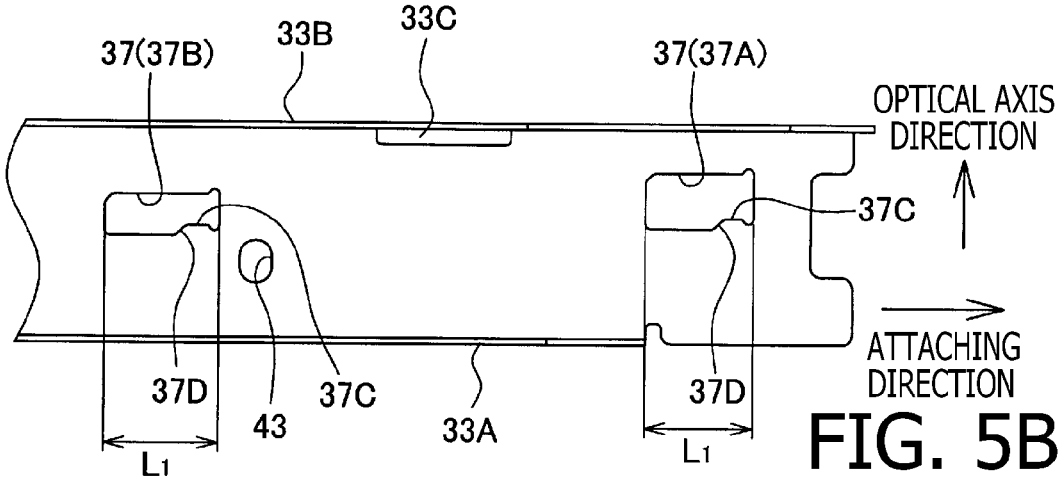


FIG. 5B

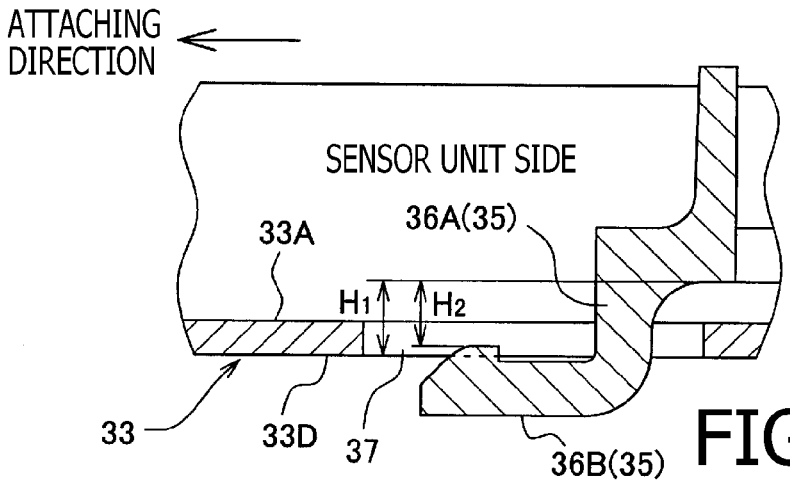


FIG. 5C

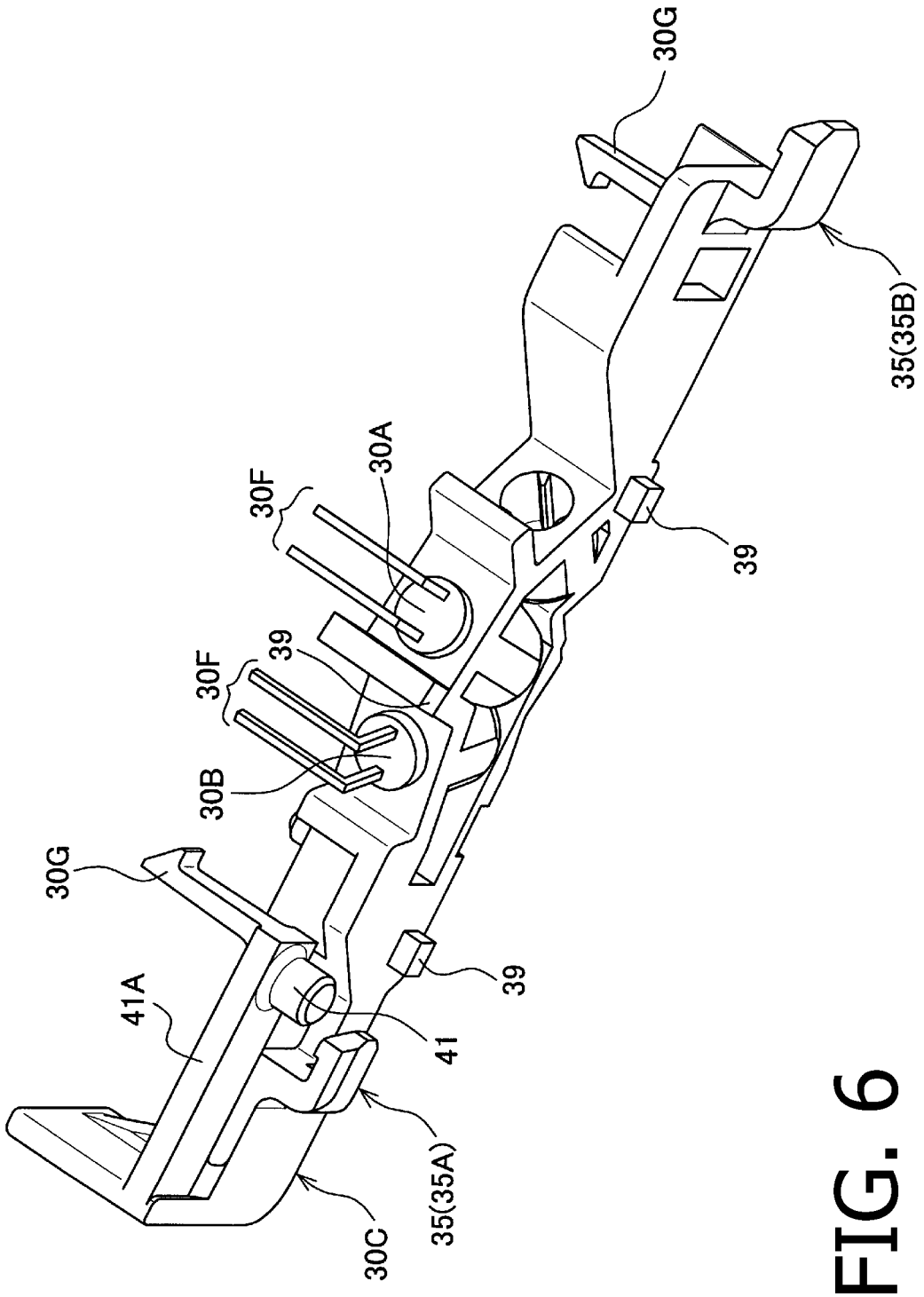


FIG. 6

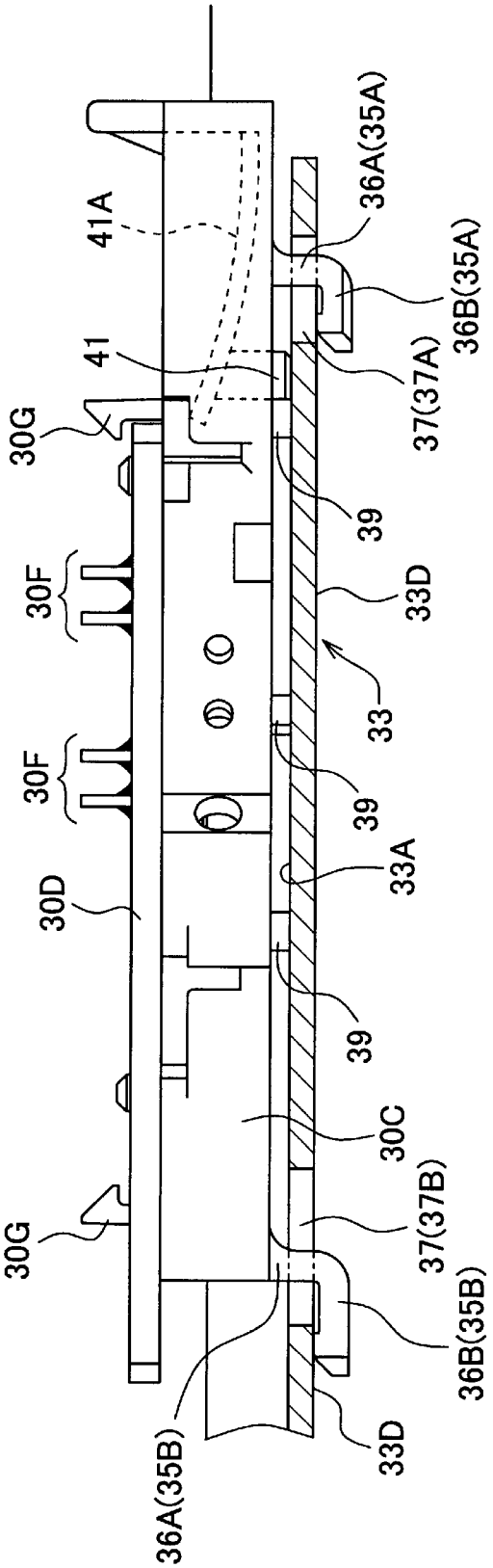

41A
36A(35A)
36B(35B)
41
37(37A)
30G
39
30F
33D
33
30F
39
33A
30D
39
30C
37(37B)
30G
36B(35B)
33D
36A(35B)

FIG. 7

IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority under 35 U.S.C. §119 from Japanese Patent Application No. 2012-259988, filed on Nov. 28, 2012. The entire subject matter of the application is incorporated herein by reference.

BACKGROUND

1. Technical Field

Aspects of the present invention relate to an image forming apparatus configured to form an image on a sheet.

2. Related Art

In general, in an image forming apparatus, a sensor unit having a light-emitting device and a light-receiving device is fixed to a main body with screws.

SUMMARY

However, if an image forming apparatus has a configuration where a sensor unit is fixe with screws, a process for screwing the sensor unit to a main body is required. Therefore, it is difficult to decrease the assembling man-hour.

Aspects of the present invention are advantageous in that they provide an improved attaching configuration of a sensor unit having a light-emitting device and a light-receiving device.

According to an aspect of the invention, there is provided an image forming apparatus, comprising: an image formation unit configured to form an image on a sheet; a sensor unit having a light-emitting device and a light-receiving device; a frame to which the sensor unit is attached; at least one projection provided on one of the sensor unit and the frame, the at least one projection being formed to have a contacting part which projects to contact an other of the sensor unit and the frame; and at least one engagement part provided on one of the sensor unit and the frame, the at least one engagement part being formed to engage with at least one catching part provided on an other of the sensor unit and the frame and to press the at least one projection in a direction of increasing a contact surface pressure of the contacting part by causing elastic deformation.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** illustrates a central cross section of an image forming apparatus according to an embodiment.

FIG. **2**A is a front view of a sensor unit viewed from a holder side, and FIG. **2**B is a top view of the sensor unit.

FIG. **3**A is a perspective view of an attachment frame to which the sensor unit is attached, FIG. **3**B illustrates a A-A cross section in FIG. **3**A.

FIG. **4**A illustrates a state where the sensor unit is attached to the attachment frame, and FIG. **4**B illustrates a state before the sensor unit is attached to the attachment frame.

FIG. **5**A is a perspective view of the attachment frame, FIG. **5**B is a top view of the attachment frame, and FIG. **5**C is an enlarged view of an engagement part.

FIG. **6** is a perspective view of a holder according to the embodiment.

FIG. **7** is an explanatory illustration for explaining features of the embodiment.

DETAILED DESCRIPTION

In the following, embodiments are described by way of example. It should be noted that elements described in the attached claims are not limited to concrete units and configurations descried in the following embodiments.

In the embodiments, the invention is applied to an image forming apparatus of an electrophotographic type. Hereafter, embodiments according to the invention will be described with reference to the accompanying drawings. It should also be noted that arrows affixed to the drawings for showing directions are provided for understanding of the relationship between the drawings, and the invention is not limited to the directions shown in the drawings.

First Embodiment

1. General Description of Image Forming Apparatus

As shown in FIG. **1**, in a housing **3** of an image forming apparatus **1**, an image formation unit **5** configured to form an image on a sheet, such as a recording sheet of paper, is accommodated. The image formation unit **5** according to the embodiment is an electrophotographic type. That is, the image formation unit **5** has a process cartridge **7**, an exposure unit **9** and a fixing unit **11**.

The image formation unit **5** according to the embodiment is configured as a color type. Therefore, the image formation unit **5** has a plurality of process cartridges **7**. Each process cartridge **7** is disposed along a direction perpendicular to an axial direction of a photosensitive drum **7**A. The process cartridges **7** respectively correspond to yellow, magenta, cyan and black.

Each process cartridge **7** is detachably attachable to a main body. The process cartridges **7** have substantially the same configuration, excepting that the process cartridges **7** differ from each other in regard to colors of stored developers. Specifically, each process cartridge **7** has the photosensitive drum **7**A, a charger **7**B and a development unit **7**C.

The term "main body" as used herein means a part, such as the housing **3** or a main frame (not shown), which is not detached or replaced by a user. The main frame is a pair of plate-like members provided to be away from each other in the width direction which is parallel with the axial direction of the photo sensitive drum **7**A. The components, such as the process cartridge **7**, constituting the image formation unit **5** are attached to the pair of main frames in a state where the components are arranged between the pair of main frames.

The photosensitive drum **7**A holds a developer image to be transferred to the sheet. The charger **7**B charges the photosensitive drum **7**A. The exposure unit **9** forms an electrostatic latent image on the charged photosensitive drum **7**A. The development unit **7**C supplies the developer to the photosensitive drum **7**A to form a developer image. Each photosensitive drum **7**A is disposed such that the axial direction thereof is perpendicular to a sheet conveying direction.

A belt **13** is an endless belt for conveying the sheet. At a position opposite to the photosensitive drum **7**A with respect to the belt **13**, a transfer unit **15** is disposed. The transfer unit **15** transfers the developer held on the photosensitive drum **7**A to the sheet being conveyed on the belt **13**. After the developer image held on each photosensitive drum **7**A is transferred to the sheet in an overlaying manner, the developer image is heated and is fixed to sheet by the fixing unit **11**.

The belt **13** is provided to extend between at least two rollers **13**A and **13**B. The roller **13**A is a drive roller which rotates the belt **13**. The roller **13**B is a driven roller which

rotates in accordance with rotation of the drive roller **13**A. A rotation center axis of each of the rollers **13**A and **13**B is parallel with the axial direction of the photosensitive drum **17**A.

On the upstream side of the belt **13** in the sheet conveying direction, a first feeder mechanism **19** and a second feeder mechanism **21** are provided. The first feeder mechanism **19** sends out the sheet placed on a paper supply tray **17** one by one toward an image formation unit **5** side. On the paper supply tray **17**, sheets to be conveyed to the image formation unit **5** are placed.

The second feeder mechanism **21** sends out the sheet placed on a multi-purpose tray (not shown) one by one toward the image formation unit **5** side. The multi-purpose tray is provided on a cover **23** disposed on the front side in the housing **3** with respect to the image formation unit **5**. When the cover **23** is swung to the front side and opened, the multi-purpose tray becomes available.

At a position facing one of the rollers **13**A and **13**B, a sensor unit **30** is disposed. As shown in FIG. **2**A, the sensor unit **30** is integrally provided with a light-emitting device **30**A and a light-receiving device **30**B.

The light-emitting device **30**A emits light toward a correction mark (not shown) formed on the belt **13**. The light-receiving device **30**B receives light reflected from the correction mark. The correction mark is a developer image transferred to the belt **13** to determine a correction amount used for correcting the shift and density of a developer image transferred to the sheet in an overlaying manner. That is, a control unit (not shown) for controlling the image formation unit **5** executes the correction as needed by controlling the various components, such as the exposure unit **9**, using a signal outputted from the sensor unit **30**.

The sensor unit **30** according to the embodiment is disposed at the position facing the roller **13**A, i.e., the drive roller. The light-emitting device **30**A and the light-receiving device **30**B are aligned along the direction parallel with the rotation center axis of the roller **13**A, i.e., the width direction, in a state where the devices **30**A and **30**B are held on a holder **30**C made of resin.

The sensor unit **30** according to the embodiment is also integrally provided with a circuit board **30**D for the light-emitting device **30**A and the light-receiving device **30**B. On the circuit board **30**D, an electric wiring **30**E for electrically connecting the sensor unit **30** to the control unit is provided.

As shown in FIG. **3**A, at least the electric wiring **30**E provided for the right side sensor unit **30** on the paper face of FIG. **3**A is laid to extend in parallel with an extending direction of a second extending part **36**B (described later), i.e., an attaching direction.

Each of the light-emitting device **30**A and the light-receiving device **30**B is held by being fitted into a hole (not shown) formed in the holder **30**C. As shown in FIG. **2**B, terminals **30**F of the light-emitting device **30**A and the light-receiving device **30**B are mounted on the circuit board **30**D by through-hole technology. Therefore, the circuit board **30**D is fixed to the holder **30**C via the light-emitting device **30**A and the light-receiving device **30**B.

2. Attaching Structure of Sensor Unit

(2.1 General Description of Attaching Structure)

The sensor unit **30** is attached to an attachment frame **33** shown in FIG. **3**A. The attachment frame **33** is a beam-like member extending in the width direction. Both ends of the attachment frame **33** in the longer side direction are attached directly or indirectly to the pair of main frames in a state where the attachment frame **33** is disposed between the pair of main frames.

In this embodiment, a plurality of sensor units **30** is provided, and the sensor units **30** are provided on both end sides in the longer side direction of the attachment frame **33**. As shown in FIG. **3**B, the attachment frame **33** has a nearly U-shaped or C-shaped cross section having an opened part in a direction perpendicular to the longer side direction.

That is, the cross-sectional shape of the attachment frame **33** is constituted by a bottom wall part **33**A and a pair of side wall parts **33**B. The bottom wall part **33**A is a zonal portion facing the sensor unit **30**. The pair of side wall parts **33**B is zonal portions which are provided at both ends of the bottom wall part **33**A in the width direction to face with each other. The attachment frame **33** is integrally formed with the bottom wall part **33**A and the pair of side wall parts **33**B, and is formed by subjecting a metal plate, such as SPCC, to press processing.

Of the pair of side wall parts **33**B, the side wall **33**B facing the roller **13**A has a window **33**C through which light passes as shown in FIG. **3**A. Therefore, the pair of side walls **33**B according to the embodiment are disposed to face with each other in the optical axis direction with respect to the sensor unit **30**.

The light-emitting device **30**A and the light-receiving device **30**B are disposed in the main body as described below. That is, the light-emitting device **30**A and the light-receiving device **30**B are disposed such that the rotational center axis of the roller **13**A is included in a virtual plane including a light ray emitted from the light-emitting device **30**A and a light ray incident on the light-receiving device **30**B after reflected from the belt **13**.

The light-emitting device **30**A and the light-receiving device **30**B are mounted such that an optical path length from the light-emitting device **30**A to the light-receiving device **30**B becomes a predetermined length. The optical axis direction means a direction which is parallel with the virtual plane and is perpendicular to the rotational center axis of the roller **13**A.

(2.2 Details of Attaching Structure)

The attaching structures for attaching the sensor units **30** to the attachment frame **33** are the same. Therefore, in the following, the detail explanation about the mounting structure is given for the sensor unit **30** mounted to the right side in FIG. **3**A.

As shown in FIG. **4**A, the sensor unit **30** is fixed to the attachment frame **33** due to a fact that elastically deformable engagement parts **35** are respectively engaged with catching parts **37** formed in the attachment frame **33**.

At least two engagement parts **35** and at least two catching parts **37** are provided in the longer side direction of the attachment frame **33**. That is, the engagement parts **35** are provided at both end portions in an extending direction of the holder **30**C extending in the longer side direction of the attachment frame **33**. The pair of catching parts **37** are provided at the positions corresponding to the pair of engagement parts **35**.

Of the pair of engagement parts **35**, the engagement part **35** on the right side on the paper surface of FIGS. **4**A and **4**B is referred to as a first engagement part **35**A, and the engagement part **35** provided on the left side on the paper face of FIGS. **4**A and **4**B is referred to as a second engagement part **35**B. The right side catching part **37** on the paper face of FIGS. **4**A and **4**B is referred to as a first catching part **37**A, and the left side catching part **37** on the paper face of FIG. **4**B is referred to as a second catching part **37**B. When the first and second engagement parts **35**A and **35**B are collectively

referred to, they are called the engagement part **35**. On the other hand, when the first and second catching parts **37**A and **37**B are collectively referred to, they are called the catching part **37**.

As shown in FIG. **4**B, the engagement part **35** is formed to have a shape of a letter "L". That is, the engagement part **35** is generally formed to have two parts, i.e., a first extending part **36**A and a second extending part **36**B, so that the engagement part **35** is formed to have a shape of a letter L. The first extending part **36**A is a projected part extending in a direction parallel with a projecting direction of a first projection **39**, i.e., extending from the sensor unit **30** to the bottom wall **33**A side.

The second extending part **36**B is a part extending from the tip of the first extending part **36**A in a direction perpendicular to the extending direction of the first extending part **36**A. In this embodiment, the second extending part **36**B of the first engagement part **35**A and the second extending part **36**B of the second engagement part **35**B extend in the same direction.

The extending direction of the second extending part **36**B is parallel with the rotational axis of the roller **13**A, i.e., the longer side direction of the attachment frame **33**. In the following, the extending direction of the second extending part **36**B, i.e., the direction pointing from the first engagement part **35**A to the second engagement part **35**B (the leftward direction in FIG. **4**B) is referred to as "attaching direction".

The first catching part **37**A is a through hole through which the first extending part **36**A of the first engagement part **35**A penetrates. Similarly, the second catching part **37**B is a through hole through which the first extending part **36**A of the second engagement part **35**B penetrates. The first and second catching parts **37**A and **37**B are formed in the bottom wall part **33**A.

In the following, the first catching part **37**A is also referred to as a first through hole **37**A. Similarly, the second catching part **37**B is also referred to as a second through hole **37**B. When the first and second through holes **37**A and **37**B are collectively referred to, the first and second through holes **37**A and **37**B are called the through hole **37**.

As shown in FIG. **5**A, the first and second through holes **37**A and **37**B have the similar hole shape. That is, the size L**1** of the longer side of each of the first and second through holes **37**A and **37**B is larger than the lengths L**21** and L**22** of the second extending parts **36**B in the extending direction shown in FIG. **2**B.

Therefore, in this embodiment, a worker is able to insert the pair of engagement parts **35** into the though holes **37**, respectively, along the direction perpendicular to the bottom wall part **33**A. When the second extending part **36**B reaches a position opposite to the sensor unit **30** with respect to the bottom wall part **33**A and the worker further moves the sensor unit **30** to the tip side in the extending direction of the second extending part **36**B, i.e., the attaching direction, each second extending part **36**B is held by contacting a peripheral portion of the through hole **37** as shown in FIG. **4**A.

At least one first projection **39** is provided on the holder **30**C, i.e., a part of the sensor unit **30**C facing the bottom wall part **33**A. The first projection **39** protrudes from the above described part of the sensor unit **30** toward the bottom wall part **33**A, and has a contacting part **39**A (which contacts the bottom wall part **33**A) at the tip of the first projection **39** in the projecting direction.

When the second extending part **36**B is engaged with the portion around the through hole **37** while contacting a surface **33**D (hereafter, referred to as an engagement surface **33**D) of the bottom wall part **33**A opposite to the sensor unit **30**, the contacting part **39**A is pressed in the direction of increasing the contact surface pressure with respect to the bottom wall part **33**A by the engagement part **35**.

That is, as shown in FIG. **5**C, in a state where the contacting part **39**A contacts the bottoms wall part **33**A and the second extending part **36**B is not engaged with the portion around the through hole **37**, the second extending part **36**B is situated on the sensor unit **30** side with respect to the engagement surface **33**D.

Specifically, before the second extending part **36**B contacts the engagement surface **33**D, the distance H**2** from a root of the first extending part **36**A to the second extending part **36**B is smaller than the distance H**1** from the root of the first extending part **36**A to the engagement surface **33**D.

Therefore, when the second extending part **36**B contacts the engagement surface **33**D and is engaged with the portion around the through hole **37**, the engagement part **35** becomes a deformed state. Therefore, in this case, the contacting part **39**A is pressed against the engagement surface **33**D.

As shown in FIG. **2**A, in this embodiment, three first projections **39** are provided between the first engagement part **35**A and the second engagement part **35**B. The three first projections **39** are disposed as described below.

The three first projections **39** are disposed such that the face center G**1** of a plane figure defined by the three first projections **39** as apexes lies within a zonal virtual area (an area surrounded by a double-chain line) connecting the two engagement parts **35**. The term "the face center of the plane figure" means a point at which the moment of area balances.

As shown in FIG. **2**A, the virtual area (the area surrounded by the double-chain line) is a zonal area which extends in parallel with the extending direction of the second extending part **36**B and in which the pair of engagement parts **35** are included.

As shown in FIG. **5**A, the through hole **37** is a substantially rectangular hole. The longer side direction of the through hole **37** is in parallel with the attaching direction. The shorter side direction of the though hole **37**, i.e., the direction perpendicular to the attaching direction is in parallel with the optical axis direction.

At a part on an outer edge of the through hole **37** parallel with the attaching direction, a pressing part **37**C protruding to the optical axis direction (on the window **33**C side in this embodiment) is provided. The pressing part **37**C contacts and presses the first extending part **36**A toward the optical axis direction when the second extending part **36**B is engaged with the portion around the through hole **37**.

Therefore, when the second extending part **36**B is engaged with the portion around the through hole **37**, the first extending part **36**A contacts the outer edge of the through hole **37**, so that movement of the engagement part **35** in the direction (i.e., the optical axis direction) perpendicular to the extending direction of the first extending part **36**A and the extending direction of the second extending part **36**B is restricted, and the engagement part **35** is positioned.

At an end part **37**D positioned on an opposite side in the attaching direction of an outer edge of the pressing part **37**C, a curved surface part connecting smoothly the pressing part **37**C with a neighboring outer edge part of the through hole **37** or a slanting part slanting with respect to the attaching direction is provided. Therefore, when the engagement part **35** moves in the attaching direction, the first extending part **36**A is prevented from being damaged, for example, by preventing the end part **37**D from cutting into the first extending part **36**A.

As shown in FIG. **4**B, at a portion of the holder **30**C, i.e., the sensor unit **30**, facing the bottom wall part **33**A, at least one second projection **41** is provided. The second projection **41**

protrudes at the portion toward the bottom wall part **33**A and fits into a recessed part **43** shown in FIG. **5**B.

Since the second projection **41** contacts the inner circumferential surface of the recessed part **43**, movement of the second projection **41** in the direction parallel with the attaching direction is restricted. As a result, the sensor unit **30** is positioned in regard to the direction parallel with the attaching direction by the second projection **41**.

In this embodiment, the recessed part **43** is formed as an elliptical through hole formed in the bottom wall part **33**A of the attachment frame **33**. The shorter side direction of the elliptical through hole is parallel with the attaching direction. On the other hand, as shown in FIG. **6**, the second projection **41** is formed to have a shape of a cylinder having the diameter equal to the size in the minor axis direction of the recessed part **43**.

Therefore, when the second projection **41** fits into the recessed part **43**, the second projection **41** contacts a portion on the inner circumferential surface of the recessed part **43** parallel with the longer side direction. As a result, movement of the second projection **41** in the minor axis direction, i.e., the direction parallel with the attaching direction, is restricted.

Furthermore, the second projection **41** is movable in the direction substantially perpendicular to the bottom wall part **33**A. Specifically, the second projection **41** is provided at the tip of an arm part **41**A of an elastically deformable cantilever type. Therefore, when the sensor unit **30** is moved in parallel with the attaching direction, the second projection **41** can be moved to the holder **39**C side. As a result, the worker is able to easily engage the engagement part **35** with the catching part **37**.

In this embodiment, a pair of snap fits **30**G for tentatively fixing the circuit board **30**D to the holder **30**C before the terminals **30**F are soldered to the circuit board **30**D are provided. In particular, the snap fit **30**G provided on the second projection **41** side is located at the tip of the arm part **41**A on the opposite side with respect to the second projection **41**. In this embodiment, the first projection **39**, the arm part **41**A, the second projection **41** and the engagement part **35** are integrally formed with the holder **30**C with resin material.

As shown in FIG. **2**A, the second projection **41** is provided on the first engagement part **35**A side with respect to the central portion between the first engagement part **35**A and the second engagement part **35**B. The length L**22** of the second extending part **36**B in the extending direction provided on the second engagement part **35**B is longer than the length L**21** of the second extending part **36**B in the extending direction provided on the first engagement part **35**A.

Therefore, in this embodiment, the geometrical moment of inertia of the second extending part **36**B of the second engagement part **35**B is larger than the geometrical moment of inertia of the second extending part **36**B of the first engagement part **35**A.

Specifically, the size W**2** in the optical axis direction of the second extending part **36**B provided on the second engagement part **35**B is larger than the size W**1** in the optical axis direction of the second extending part **36**B provided on the first engagement part **35**A.

3. Feature of Image Forming Apparatus of Embodiment

As described above, in this embodiment, the contacting part **39**A of the first projection **39** contacts the attachment frame **33** in a state where the first projection **39** is pressed against the attachment frame **33**. Therefore, the sensor unit **30** is attached to the attachment frame **33** in the state where the sensor unit **30** is positioned with respect to the attachment frame **33**.

That is, according to the embodiment, the sensor unit **30** can be positioned and attached to the attachment frame **33** without using screws. In addition, fixing by engagement requires less man-hour relative to fixing by screws. Therefore, according to the embodiment, it is possible to attach the sensor unit **30** to the attachment frame **33** with a high degree of precision while decreasing man-hour for attachment.

In this embodiment, the position of the sensor unit **30** in the optical axis direction is restricted by the first extending part **36**A. The position of the sensor unit **30** in the direction parallel with the extending direction of the second extending part **36**B is restricted by the second projection **41**. Furthermore, the position of the sensor unit **30** in the optical axis direction and the direction perpendicular to the extending direction of the second extending part **36**B is restricted by the first projection **39**.

Therefore, the worker is able to easily attach the sensor unit **30** to the attachment frame **33** while positioning the sensor unit **30** in regard to the above described three directions which are perpendicular to each other, by translating the sensor unit **30** in the extending direction of the second extending part **36**B, i.e., in the attaching direction.

In this embodiment, the second extending part **36**B extends in the direction pointing from the first engagement part **35**A side to the second engagement part **35**B side. The second projection **41** is provided on the first engagement part **35**A side with respect to the center between the first engagement part **35**A and the second engagement part **35**B. The length L**22** of the second extending part **36**B in the extending direction provided on the second engagement part **35**B is larger than the length L**21** in the extending direction of the second extending part **36**B provided on the first engagement part **35**A.

With this configuration, in this embodiment, the worker is able to engage the second engagement part **35**B to the second catching part **37**B before the second projection **41** is fitted into the recessed part **43** as shown in FIG. **7**. As a result, the worker is able to fit the second projection **41** into the recessed part **43** by handling the sensor unit **30** as a lever such that the second engagement part **35**B side serves as the point of support of the lever, the first engagement part **35**A side serves as the power point of the lever, and the second projection **41** serves as the point of action of the lever. Therefore, the worker is able to easily attach the sensor unit **30** to the attachment frame **33**.

As shown in FIG. **7**, the second projection **41** moves in the direction of departing from the bottom wall part **33**A before the second projection **41** fits into the recessed part **43** during the above described attachment work. Therefore, the worker is able to easily attach the sensor unit **30** to the attachment frame **33** thanks to the effect of the above described "lever".

Furthermore, in this embodiment, the geometrical moment of inertia of the second extending part **36**B provided on the second engagement part **35**B is larger than the geometrical moment of inertia of the second extending part **36**B provided on the first engagement part **35**A.

As a result, in this embodiment, it is possible to prevent the second extending part **36**B of the second engagement part **35**B from being deformed excessively even when the length L**22** in the extending direction of the second extending part **36**B provided on the second engagement part **35**B is larger than the length L**21** in the extending direction of the second extending part **36**B provided on the first engagement part **35**A.

Furthermore, as shown in FIG. **3**A, the electric wiring **30**E provided for the sensor unit **30** is extended in the direction parallel with the extending direction of the second extending part **36**B, i.e., the electric wiring **30**E is extended from the right side to the left side on the paper face of FIG. **3**A.

With this configuration, if the electric wiring **30**E is pulled in the extending direction of the electric wiring **30**E, i.e., in the attaching direction, the first extending part **36**A contacts the outer edge of the through hole, i.e., the catching part **37**.

Therefore, the sensor unit **30** never moves together with the electric wiring **30**E. Consequently, even when the electric wiring **30**E is pulled strongly by the worker in the extending direction of the electric wiring **30**E, the sensor unit **30** is never detached from the attachment frame **33**.

In this embodiment, at least three first projections **39** are provided, and the face center G**1** of a plane figure dined by the plurality of first projections **39** as apexes lies within the zonal virtual area connecting the two engagement parts **35**. As a result in this embodiment, the sensor unit **30** can be positioned in a stable state.

OTHER EMBODIMENTS

In the above described embodiment, the first projection **39**, the second projection **41** and the engagement part **35** are provided on the sensor unit **30**, and the catching part **37** and the recessed part **43** are provided on the attachment frame **33**; however, the present invention is not limited to such a configuration. For example, the first projection **39**, the second projection **41** and the engagement part **35** may be provided on the attachment frame **33**, and the catching part **37** and the recessed part **43** may be provided on the sensor unit **30**.

In the above described embodiment, two engagement parts **35** are provided; however, the present invention is not limited to such a configuration. One engagement part **35** or more than two engagement parts **35** may be provided.

In the above described embodiment, the catching part **37** is formed as a through hole formed to penetrate through the attachment frame **33**; however, the present invention is not limited to such a configuration. For example, the catching part **37** may be formed as an L-shaped hole having vertical and horizontal holes.

In the above described embodiment, the engagement part **35** causes almost no elastic deformation when the engagement part **35** is inserted into the through hole catching part **37**, i.e., the through hole **37**, but the engagement par **35** causes elastic deformation when the engagement part **35** is moved in the attaching direction and thereby the second extending part **36**B contacts the engagement surface **33**D. However, the present invention is not limited to such a configuration. For example, the engagement part **35** may be inserted into the catching part **37** while being elastically deformed, as in the case of a snap fit.

In the above described embodiment, the second projection **41** is provided on the first engagement part **35**A side with respect to the center between the first engagement part **35**A and the second engagement part **35**B; however, the present invention is not limited to such a configuration. For example, the second projection **41** may be provided on the second engagement part **36**B side with respect to the center between the first engagement part **35**A and the second engagement part **35**B.

In the above described embodiment, the second projection **41** is able to shift in the direction substantially perpendicular to the bottom wall part **33**A; however, the present invention is not limited to such a configuration.

In the above described embodiment, the length L**22** in the extending direction of the second extending part **36**B provided on the second engagement part **35**B is longer than the length L**21** in the extending direction of the second extending part **36**B of the first engagement part **35**A; however, the present invention is not limited to such a configuration. The length L**22** and the length L**21** may be set to have the same length, or the length L**22** may be set to be shorter than the length L**21**.

In the above described embodiment, the geometrical moment of inertia of the second extending part **36**B provided on the second engagement part **35**B is larger than the geometrical moment of inertia of the second extending part **36**B provided on the first engagement part **35**A; however, the present invention is not limited to such a configuration. The two geometrical moments of inertia may be set to be equal to each other or the magnitude relation of the two geometrical moments of inertia may be reversed.

In the above described embodiment, the first engagement part **35**A and the second engagement part **35**B are made of the same material, and therefore the geometrical moments of inertia of the first and second engagement parts **35** are differentiated to each other. However, the present invention is not limited to such a configuration. Specifically, the first engagement part **35**A and the second engagement part **35**B may be made of different materials, so that the flexural rigidity of the second extending part **36**B provided on the second engagement part **35**B becomes larger than the flexural rigidity of the second extending part **36**B provided on the first engagement part **35**A.

In the above described embodiment, the electric wiring **30**E is provided to extend in the direction substantially parallel with the extending direction of the second extending part **36**B; however, the present invention is not limited to such a configuration. The electric wiring **30**E may be provided to extend in another direction.

In the above described embodiment, the face center G**1** of a plane figure dined by the plurality of first projections **39** as apexes lies within the zonal virtual area connecting the two engagement parts **35**. However, the present invention is not limited to such a configuration. For example, the face center G**1** may be located outside the above described zonal virtual area.

The sensor unit **30** according to the embodiment is an optical sensor which reads a correction mark formed on the belt **13**. However, the present invention is not limited to such a configuration. The sensor unit **30** may be a sensor unit for use of another purpose, such as, detection of the remaining amount of developer.

In the above described embodiment, the engagement part **35** and the first projection **39** are integrally formed with the holder **30**C. However, the present invention is not limited to such a configuration. The engagement part **35** and the first projection **39** may be separately provided.

In the above described embodiment, the pressing part **37**C is formed to project on the window **33**C side; however, the present invention is not limited to such a configuration. For example, the pressing part **37**C may be formed to project on the opposite side of the window **33**C or the pressing part **37**C may be omitted.

What is claimed is:

1. An image forming apparatus, comprising:

an image formation unit configured to form an image on a sheet;

a sensor unit having a light-emitting device and a light-receiving device;

a frame to which the sensor unit is attached;

at least one projection provided on one of the sensor unit and the frame, the at least one projection being formed to have a contacting part which projects to contact the other of the sensor unit and the frame;

at least one engagement part provided on one of the sensor unit and the frame, the at least one engagement part being formed to engage with at least one catching part provided on the other of the sensor unit and the frame and to press the at least one projection in a direction of increasing a contact surface pressure of the contacting part by causing elastic deformation; and

a projecting part provided on one of the sensor unit and the frame, the projecting part being formed to fit into a recessed part formed in the other of the sensor unit and the frame;

wherein:

the at least one engagement part comprises a first engagement part and a second engagement part;

each of the first engagement part and the second engagement part comprises a first extending part formed to extend in a direction parallel with a projecting direction of the at least one projection, and a second extending part formed to extend in a direction perpendicular to an extending direction of the first extending part from a tip of the first extending part in the extending direction of the first extending part, so that each of the first engagement part and the second engagement part is formed in shape of a letter L;

the second extending part of the first engagement part and the second extending part of the second engagement part extend in a same direction;

the at least one catching part comprises a first through hole through which the first extending part of the first engagement part penetrates and a second through hole thorough which the first extending part of the second engagement part penetrates;

the second extending parts of the first engagement part and the second engagement part engage with portions around the first through hole and the second through hole, respectively;

the first extending parts of the first engagement part and the second engagement part contact outer edges of the first through hole and the second through hole, respectively, so that movement of the first extending parts of the first engagement part and the second engagement part in a direction perpendicular to the extending direction of the first extending part and an extending direction of the second extending part is restricted; and

the projecting part is formed to contact an inner edge of the recessed part so that movement of the projecting part in the extending direction of the second extending part is restricted.

2. The image forming apparatus according to claim **1**,

wherein the at least one projection is provided between the first and second engagement parts.

3. The image forming apparatus according to claim **1**,

wherein:

the second extending part of each of the first engagement part and the second engagement part extends in a direction pointing from the first engagement part to the second engagement part;

the projecting part is provided on a side closer to the first engagement part with respect to a center between the first engagement part and the second engagement part; and

a length in the extending direction of the second extending part provided on the second engagement part is longer than a length in the extending direction of the second extending part provided on the first engagement part.

4. The image forming apparatus according to claim **3**,

wherein a geometrical moment of inertia of the second extending part provided on the second engagement part is larger than a geometrical moment of inertia of the second extending part provided on the first engagement part.

5. The image forming apparatus according to claim **1**,

wherein an electric wiring provided for the sensor unit extends in a direction substantially parallel with the extending direction of the second extending part of each of the first engagement part and the second engagement part.

6. The image forming apparatus according to claim **2**,

wherein:

the at least one projection comprises at least three projections;

a face center of a plane figure defined by the at least three projections as apexes lies within a zonal virtual area connecting the two engagement parts.

7. The image forming apparatus according to claim **1**,

further comprising a belt provided to extend between at least two rollers,

wherein:

the at least one engagement part comprises a first extending part formed to extend in a direction parallel with a projecting direction of the at least one projection, and a second extending part formed to extend in a direction perpendicular to an extending direction of the first extending part from a tip of the first extending part in the extending direction of the first extending part, so that the at least one engagement part is formed in a shape of a letter L;

the at least one catching part is a through hole through which the first extending part penetrates;

the second extending part engages with a portion around the through hole;

the first extending part contacts an outer edge of the through hole so that movement of the first extending part in a direction perpendicular to the extending direction of the first extending part and an extending direction of the second extending part is restricted; and

the extending direction of the second extending part is parallel with a center axis of each of the at least two rollers.

8. An image forming apparatus, comprising:

an image formation unit configured to form an image on a sheet;

a sensor unit having a light-emitting device and a light-receiving device;

a frame to which the sensor unit is attached;

at least one projection provided on one of the sensor unit and the frame, the at least one projection being formed to have a contacting part which projects to contact the other of the sensor unit and the frame;

at least one engagement part provided on one of the sensor unit and the frame, the at least one engagement part being formed to engage with at least one catching part provided on the other of the sensor unit and the frame and to press the at least one projection in a direction of increasing a contact surface pressure of the contacting part by causing elastic deformation; and

a belt provided to extend between at least two rollers;

wherein:

the at least one engagement part comprises a first extending part formed to extend in a direction parallel with a pro-

jecting direction of the at least one projection, and a second extending part formed to extend in a direction perpendicular to an extending direction of the first extending part from a tip of the first extending part in the extending direction of the first extending part, so that the at least one engagement part is formed in a shape of a letter L;

the at least one catching part is a through hole through which the first extending part penetrates;

the second extending part engages with a portion around the through hole;

the first extending part contacts an outer edge of the through hole so that movement of the first extending part in a direction perpendicular to the extending direction of the first extending part and an extending direction of the second extending part is restricted; and

the extending direction of the second extending part is parallel with a center axis of each of the at least two rollers.

* * * * *